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A Coordinated LVRT Control for a PMSG Wind Turbine

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Abstract: This paper proposes a coordinated controller for a permanent-magnet synchronous generator wind turbine to enhance its low voltage ride through capability. In the proposed method, both rotor side and grid side converters are cooperatively controlled to regulate the DC link voltage during the grid fault. Moreover, at the fault clearance, the grid side converter produces the previous power value which is the maximum power in normal operation. It prevents excessive power production at the fault clearance in order to reduce the rotor load. From the proposed method, better transient response of the DC link voltage could be obtained with less rotor acceleration. We validated the proposed method using MATLAB/Simulink SimPowerSystems and compared the performances of with and without the coordinated control.

Keywords: Coordinated controller, Sliding mode control, Low voltage ride through

- Nomenclature
  - PMSG : Permanent magnet synchronous generator
  - WPS : Wind power system
  - DFIG : Doubly-fed induction generator
  - MPPT : Maximum power point tracking
  - FRT : Fault ride through
  - LVRT : Low voltage ride through
  - WT : Wind turbine
  - SMC : Sliding mode control
  - RSC : Rotor-side converter
  - GSC : Grid-side converter
  - PCC : Point of common coupling
  - PI : Proportional-integral

1. INTRODUCTION

The wind power generation is taken notice as one of the most growing renewable energy in terms of its costs and benefits. PMSG in WPS has many advantages in comparison with the DFIG wind systems. These advantages are high power density, no gearbox, simple control method and high precision, whereas PMSG needs to high initial installation costs Polinder et al. (2006); Chinchilla et al. (2006) because of the use of permanent magnet. When the penetration level is not significant, WPS only has a control objective of MPPT control which could be achieved by model based or model free methods Kim et al. (2017). As wind energy penetration level in the electrical power systems increases, many grid codes requires that wind power systems remain connected to the grid during the event of network disturbances Tsili and Papathanassiou (2009). Otherwise, the sudden disconnections of wind turbines when the grid faults could result in cascaded generation outage. For this reason, grid codes describe that large wind power plants are required to remain connected to the grid when voltage dips down to a certain percentage of the nominal voltage (0% in some cases) for a specified duration Tsili and Papathanassiou (2009). And these specific requirements are decided considering the power system characteristics. Such requirements are known as FRT or LVRT requirements for wind power plants and many countries think it as one of the most important thing for grid integration to the power system. Grid codes describe voltage characteristics against time, denoting the minimum required time to be connected during the dips of the system voltage Tsili and Papathanassiou (2009). Fig. 1 shows the LVRT requirements of Germany(E.ON), Great Britain, and Denmark Tsili and Papathanassiou (2009) and each countries have substantial wind power penetration level.

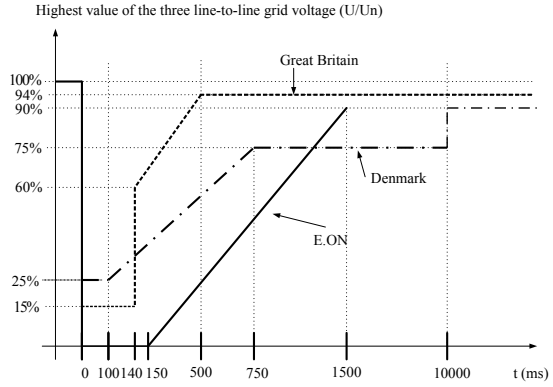

Fig. 1. Limit curves for the voltage to allow generator disconnection Tsili and Papathanassiou (2009).

To satisfy these requirements during faults, several methods for PMSG WT were proposed Saccomando et al. (2002); Mullane et al. (2005); Matas et al. (2008); Conroy and Watson (2007); Kim et al. (2012); Alepuz et al. (2013); Wang et al. (2010); Gui et al. (2015, 2016). For a PMSG WT system, the effects of voltage dips on the performance of the controller under

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